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INTEGRATED LOGISTICS SUPPORT IN THE UNITED
STATES NAVY'S SHIPBUILDING PROGRAM

by

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for improving program management, life-cycle logistics support, and ILS education for future shipbuilding programs.

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Integrated Logistics Support in the United States Navy's Shipbuilding Program

by

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Lieutenant Commander, United States Navy
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ABSTRACT

The acquisition of a large class of ships is a complex and costly undertaking. To bring the myriad of elements which comprise the Integrated Logistics Support(ILS) effort to bear on the process of acquiring ships/systems in the most efficient manner possible, requires an acquisition environment which supports the intensive effort required to achieve ILS objectives. This thesis examines the ILS efforts associated with the U.S. Navy's acquisition of FFG-7 Class ships from conception through operational deployment. Included are the design-to-cost and fly-before-buy concepts and the change in ship's operational tasking. Recommendations are provided for improving program management, life-cycle logistics support, and ILS education for future shipbuilding programs.

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I. INTRODUCTION

A. BACKGROUND

> System readiness is a primary objective of the acquisition process. It is Department of Defense(DOD) policy to ensure that resources to achieve readiness receive the same emphasis as those required to achieve schedule and performance objectives. These resources shall include those necessary to design desirable support characteristics into systems and equipment as well as those to plan, develop, acquire, and evaluate the support.[1]

In adhering to DOD policy, Secretary of the Navy Instruction (SECNAVINST) 5000.1 requires that each acquisition program charter include the designation of a Logistics Manager to assist the Program Manager.[2] Integrated Logistics Support(ILS) is to be considered throughout the acquisition process in order to assure cost consciousness and effective life-cycle support for fleet systems. The DOD definition of ILS is:

> A disciplined, unified, and iterative approach to the management and technical activities necessary to: (a) integrate support considerations into system and equipment design; (b) develop support requirements that are related consistently to readiness objectives, to design, and to each other; (c) acquire the required support; and (d) provide

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[1] U.S. Department of Defense Directive 5000.39, Acquisition and Management of Integrated Logistic Support for Systems and Equipment, 17 November 1983, p. 2.

[2] George S. Handler, George Hemmerle, and William Rucker, "Navy Program Manager's Guide", January 1985, U.S. Naval Material Command, Washington, D.C., p. 1-9.

the required support during the operational phase at minimum cost.[3]

ILS pulls together concept, design, test and evaluation, production, and operations into the continuous development of systems to be used by today's Navy.[4] The entire ILS effort is a iterative process throughout the life of a system. And DOD guidance delineates specific ILS considerations for Milestones 0, I, II, and III.[5] In particular, an ILSP (Integrated Logistics Support Plan) must be developed during the Concept Exploration Phase and be completed by Milestone I of the acquisition process.

While logistic support has long been recognized by the military as an essential element in accomplishing military objectives, it was not until the the early 1960's that the ILS concept was considered as a possible solution to logistic support problems in DOD system acquisition efforts. The first ILS instructions surfaced in DOD in 1964, and in the Naval Material Command in 1966. However, it was not until 1971 that the Navy became serious about ILS due

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[3] U.S. Department of Defense Directive 5000.39, Acquisition and Management of Integrated Logistic Support for Systems and Equipment, 17 November 1983.

[4] Robert A. Bobulinski, "A Study of an Integrated Logistic Support Application on a Surface Ship New Construction Program" (Masters Thesis, U.S. Naval Postgraduate School, Monterey, CA, December 1976), p. 9.

[5] Department of Defense Directive 5000.39, Acquisition and Management of Integrated Logistic Support for Systems and Equipment, 17 November 1983, Encl (3), pp. 1-5.

to shrinking defense budgets and the potential cost savings afforded by the application of the ILS concept to the system acquisition process. Admiral Elmo Zumwalt, then Chief of Naval Operations, and Admiral J.D. Arnold, then Chief of Naval Material, promulgated instructions which assigned the responsibility for the planning and acquisition of ILS to those individuals acquiring particular end items. Those instructions were a result of the Navy's concern that: a) logistic planning information was being received too late or not at all, b) supply support was poor, and c) technical publications were inadequate, outdated, and contradictory.

B. OBJECTIVE

The objective of this thesis is to examine the effectiveness of the Integrated Logistics Support process, as it is applied to the Navy's shipbuilding program, from an operator's point of view. More than sixteen years after recognizing the importance of considering life-cycle logistic support factors in system design, the Navy's ships in the fleet continue to be plagued with logistic support problems. While the Navy seems to actively pursue ILS objectives early in the acquisition of a system, it appears that basic ILS principles are neglected as the system matures in its life cycle.

The objective of this thesis is not to reach definitive solutions to problems associated with ILS execution, but rather, to provide background information and a series of facts to stimulate discussion and empirical analysis among those individuals involved in ILS efforts. The author is also concerned that, while they play a major role in system life-cycles, end users/operators of acquired systems are largely ignorant of the basic principles of ILS and therefore, unknowingly, contribute to the less than optimum achievement of ILS objectives.

C. SCOPE

The FFG-7 class ship acquisition program was chosen as an example because it was the first such major ship acquisition made by the U.S. Navy which was to be procured utilizing ILS principles as set forth by DOD. Also, the author was assigned duties as Commissioning Engineer Officer on the 25th ship of the class and gained first-hand knowledge of ILS from an operator/end user perspective. It is hoped that the author's experiences and facts taken from research will provide an insight into the end user/operator's view of ILS efforts in the Navy's shipbuilding program.

D. PREVIEW

Chapter II describes the ILS process as it applies to the U.S. Navy's shipbuilding and acquisition program. The purpose of the description is to provide the reader with an understanding of the importance of ILS in the U.S. Navy's ship acquisition process.

Chapter III presents both the author's and the FFG-7 Program Management Office's views concerning the application and effectiveness of ILS in the Navy's FFG-7 Class ship acquisition program.

Chapter IV examines the effects of several U.S. Navy acquisition concepts and ILS concerns on its OLIVER HAZARD PERRY (FFG-7) Class ship acquisition program.

Chapter V presents a summary of the thesis, and conclusions and recommendations concerning the ILS process as it is applied to the Navy's acquisition of entire ship classes.

II. ILS IN SHIP/SYSTEM ACQUISITION

The acquisition of a new class of ships for the U.S. Navy is an extremely detailed and complex process involving a wide range of organizations and disciplines which come together to formulate the design, prepare detailed engineering plans, estimate the cost, secure the budget, and finally manage the building of the final product. Integrated Logistics Support should be the glue by which the numerous disciplines and organizations are bound together throughout the acquisition process and the life cycle of the ship/system being procured.

In the U.S. Navy, ship acquisition programs consist of five phases. The phases are (1) Program Initiation, (2) Concept Exploration, (3) Demonstration and Validation, (4) Full Scale Development, and (5) Production/Deployment. The starting point for the acquisition process cannot be pinpointed. It emerges gradually from the naval operational experience, advances in the technology base, and intelligence assessment of the threat - all integrated through ongoing mission area analysis. Based on the threat, the Department of the Navy (DON) evaluates a mission need with respect to other needs, existing capabilities, priorities, and resources. If the

evaluation results in the validation of the particular mission need, DON then prepares a requirements document describing the mission need and forwards it to the Secretary of the Navy for consideration and approval.

Figure 1 provides an overview of the phases of the acquisition process and their interrelationships with the numerous elements of ILS. As this figure shows, the elements of ILS should provide the boundary within which the acquisition process takes place. The principal elements of ILS include planning for maintenance, manpower and personnel, training and training support, supply support, transportation and handling, and design interface requirements. ILS plays an important role in each of the five acquisition phases because it is a composite of all considerations necessary to assure the effective and economical support of a system for its life cycle.

During the Concept Exploration phase, ILS requires that reliability, maintainability, availability, and supportability(RMA&S) factors be considered in the design of the ship/system. This phase entails the solicitation and evaluation of alternative concepts designed to meet the requirements of the mission need. Alternative concepts are compared based on costs, schedule, readiness

objectives, and affordability factors. Preliminary Logistics Support Analyses(LSA's) provide the vehicle by which the systems and their components are evaluated.

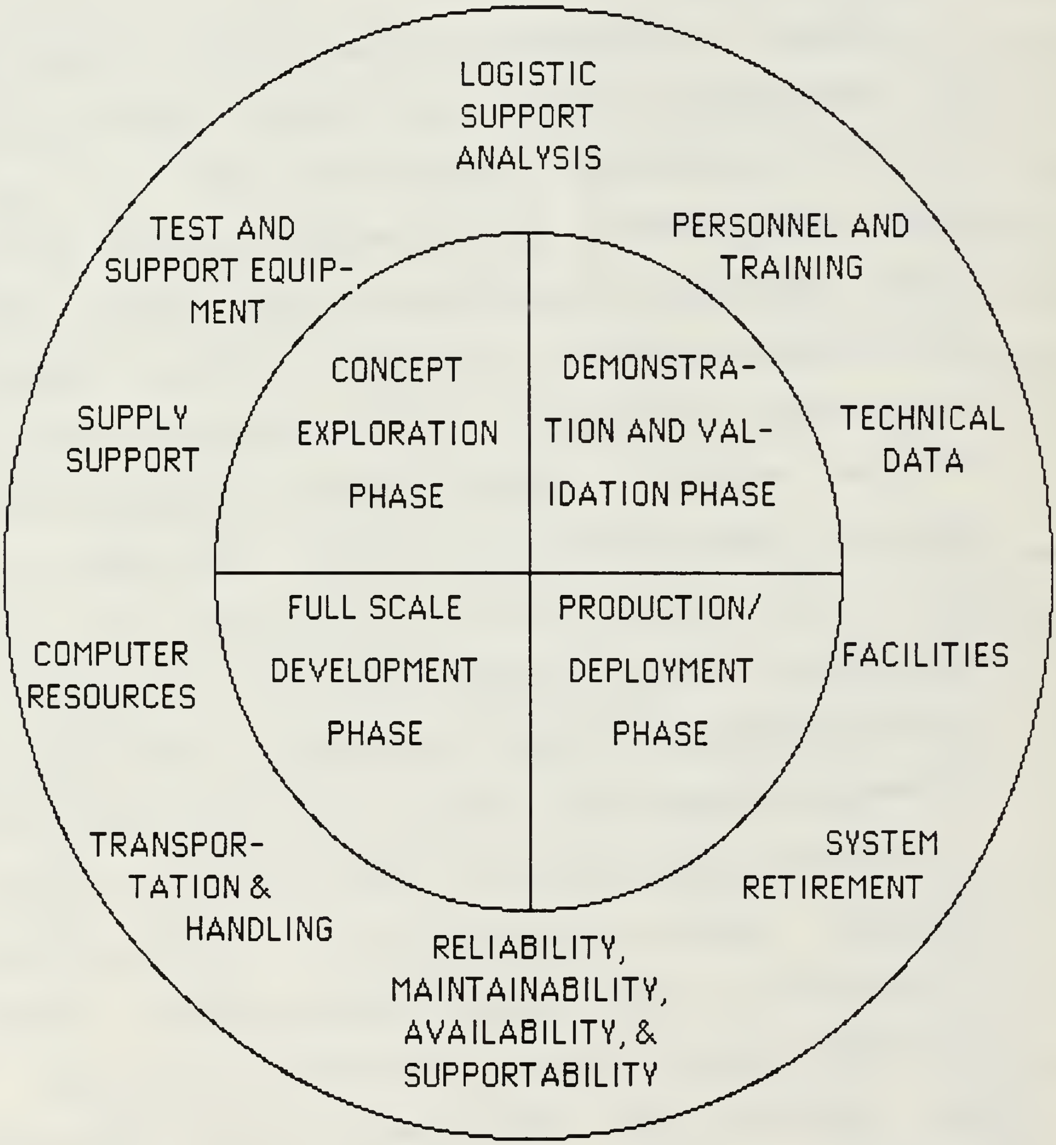

Figure 1. ILS/ACQUISITION INTERFACE

Over a system's life cycle, LSA's are used iteratively to identify and evaluate the logistic support necessary for a new system. As a design analysis tool, LSA's include maintenance analysis, level of repair analysis(LORA), life-cycle costs(LCC) analysis, and logistic support modeling. Costs included in a LCC analysis include research and development, production and construction, operation and maintenance, and system retirement and phaseout costs.

The primary ILS products of the Concept Exploration phase of the acquisition process are the preliminary Integrated Logistics Support Plan(ILSP) which may include the Logistics Support Analysis Plan(LSAP). The ILSP covers all logistics activities throughout the system life-cycle while the LSAP concentrates on specific program requirements as related to system/logistics functions, LSA program tasks, task input/output requirements, organization approach and interface requirements, and data item requirements. These plans form the basis for reliability, maintainability, human factors, and logistics considerations in the design process.[6]

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[6]Benjamin S. Blanchard, Logistics Engineering and Management, 3rd Edition, (Englewood Cliffs, NJ: Prentice Hall, Inc., 1986), pp. 429-433.

The Demonstration and Validation phase involves continued iterative design and demonstration of the system or critical subsystems to verify performance, ascertain the potential suitability of a concept to fill the mission need, and to establish a credible baseline LCC cost estimate. The ILSP, LSAP, and LSA's are validated and/or updated based on the results of the selected test and evaluation criteria. The selected criteria are usually threshhold values for reliability, maintainability, availability, and supportability (RMA&S) factors. The ILSP is significantly expanded at this time to cover all subsequent integrated logistics support elements and activities throughout the system life-cycle. The ILSP includes a set of sub-plans which serve as road maps for achieving program technical and management requirements(See Figure 2).

The goal of the Full-Scale Development(FSD) phase is to produce a fully tested, documented, and production-engineered design of the concept selected in the Demonstration and Validation phase. Critical design review is conducted through the use of simulations incorporating the RMA&S factors previously determined. In the U.S. Navy's shipbuilding programs, prototype testing and evaluation are accomplished

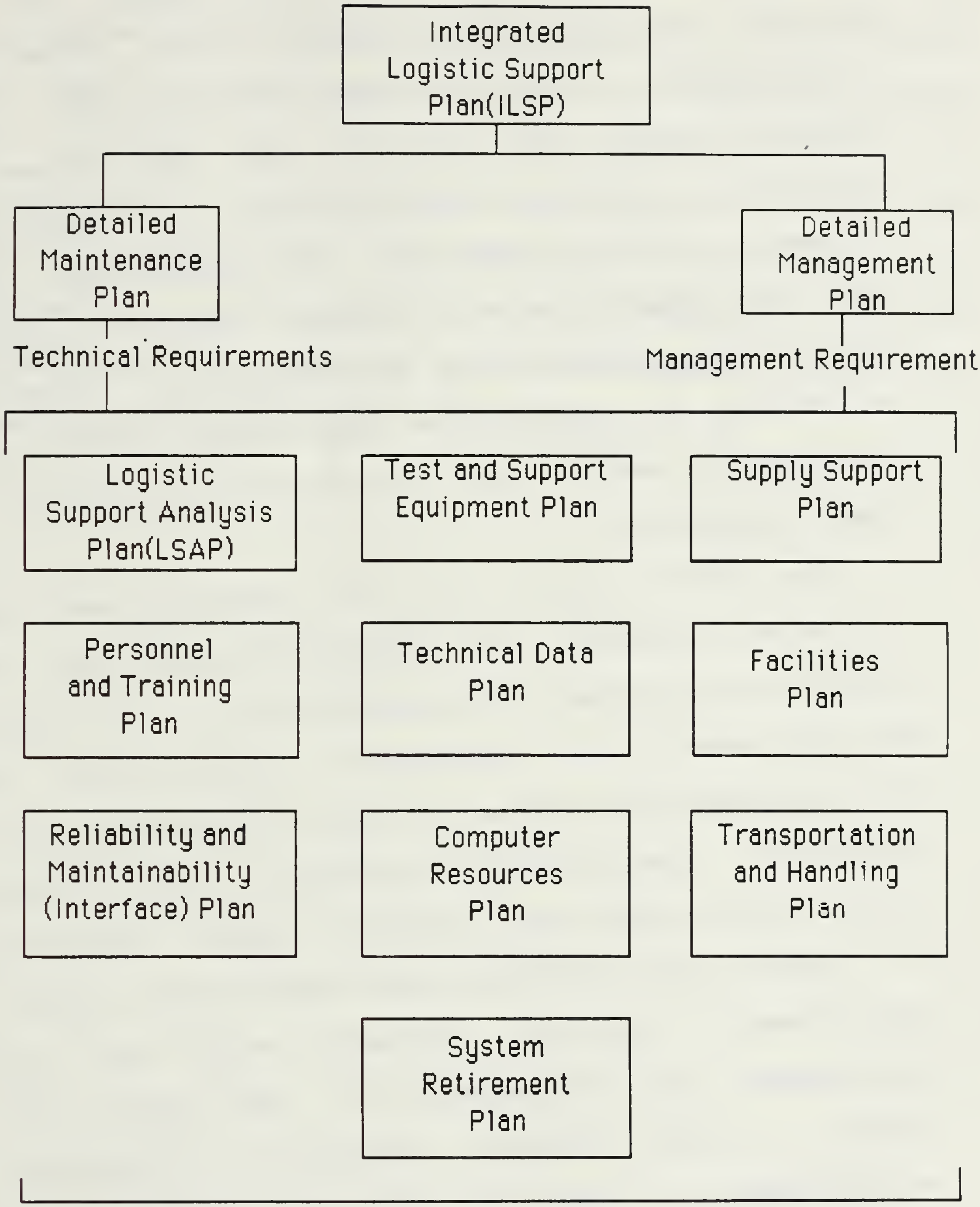

Figure 2. LOGISTICS SUPPORT PLAN ELEMENTS[7]

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[7]Ibid., p. 328.

through extensive use of surrogate ships, and combat systems and propulsion plant Land Based Test Sites(LBTS's). In the case of the FFG-7 Class, systems planned for use on that ship class were installed, tested, and evaluated on existing ship classes. Pilot production is accomplished through the lead-ship/follow-ship concept where a contract is let for the production of one ship only. Then, based on results of testing the lead-ship, design changes are made as needed prior to letting contracts for full scale production.

The FSD phase can be characterized as an iterative process of design-test-redesign, again taking into account all elements of the ILS process. The end result is a base-line configuration design and documentation package which represents a cost effective, operationally suitable, and producible system which meets the original mission requirement.

During the Production and Deployment phase, the development activity proceeds with the planned procurement and introduction of the system into the Fleet. Full scale, economic production is accomplished with quality assurance controls in place to ensure the final product meets design specifications.

The elements of ILS are continually reviewed throughout the production and deployment of the system in order to determine the degree to which the system is capable of meeting the original mission requirements. RMA&S factors are monitored and updated as the system and its components function in the operational environment. Where necessary, product improvements are made to ensure the system operates as designed throughout its life-cycle.

III. WHERE DO WE STAND?

A. INTRODUCTION

Since adopting an ILS policy for the procurement of ships, the Navy has attempted to achieve ILS objectives within the its current organizational framework. Though the Navy cannot state unequivocably that it has succeeded in achieving those objectives, it can say that it has made substantial progress. However, the Navy's progress is concentrated in the early phases of the acquisition process rather than the entire life-cycle of ships procured.

The concept under which the OLIVER HAZARD PERRY (FFG-7) Class Guided Missile Frigate Class was born was the result of a strategic study launched in 1970 by the Chief of Naval Operations, Admiral Elmo Zumwalt.[8] Out of the study was born the idea that if the surface Navy was to remain a viable naval force as military budgets continued to shrink, then the procurement of expensive and highly capable ships must be reduced and supplemented by the procurement of a greater number of lower cost and less capable ships. This concept became known as the "high-low mix" strategy and was the impetus for the Patrol Frigate,

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[8]Frederick B. Easton, "Case Study: FFG-7 Class Ship" (Masters Thesis, U.S. Naval Postgraduate School, Monterey, CA, June 1978), p. 15.

later redesignated the OLIVER HAZARD PERRY (FFG-7) Class Guided Missile Frigate. The "high-low mix" concept was deeply rooted in the Navy's two primary tactical missions, projection and sea control,

To accomplish its projection mission, the Navy requires expensive and highly capable platforms to operate in what are considered to be high threat locations. Of course, the Navy would prefer such platforms to accomplish any mission, but continually austere budget constraints will not permit such luxury. To accomplish its sea control mission, the Navy is required to keep open vast expanses of ocean which are not considered to be high threat locations. Thus, while projection requires highly capable and expensive ships, sea control requires less expensive and capable ships, but in much greater numbers to cover the vast ocean areas. FFG-7's were to be a major component of the low end of the high-low mix strategy. The ship class was to be a small inexpensive surface combatant capable of providing open ocean escort support for amphibious, logistical, and merchant convoys in a low threat environment. The ship would not be designed for carrier escort or battle group operations.

B. PROGRAM MANAGEMENT

1. Chronology

A chronology of major events in the FFG-7 Class Acquisition Program is provided in Appendix A. The chronology includes those events considered major by the FFG-7 Class Program Management Office(PMO). The period covered by the chronology is 1970-1984. The PMO is currently updating the chronology to include the period from 1984 to 1987. However, the information being compiled is not available to the author.

2. ILS Management Organization

The FFG-7 Class ILSP was developed in 1975. Its executive summary stated that ILS planning for maintenance, supply support, and manning of the FFG-7 Class is based on the Projected Operational Environment, which establishes the most demanding operational condition for which a ship must be manned; i.e., at sea in wartime performing open escort missions in low threat locations. Under this condition the ship must be capable of performing offensive and defensive tasks, simultaneously, in condition I(General Quarters/Battle Stations); performing functions as specified in the Required Operational Capabilities; maintaining readiness condition III(wartime cruising) continuously at sea

for sixty days; and performing all maintenance for which ship's company is assigned responsibility. In meeting these requirements, two principal ILS objectives guided the development of the ILSP for the FFG-7 Class:

1. to minimize shipboard manning.
2. to minimize the off-line time for depot level maintenance, thereby increasing at-sea utilization."[9]

The FFG-7 Class Ship Acquisition Program was established by Commander, Naval Ship Systems Command Instruction, NAVSHIPINST 5430.101, dated 24 August 1971 (now cancelled), and was later established as a Naval Sea Systems Command Designated Project by Commander, Naval Sea Systems Command Instruction, NAVSEAINST 5400.49, dated 7 June 1977. The latter instruction was superseded by NAVSEAINST 5400.49A, dated 9 November 1981. This instruction assigned responsibility for life-cycle logistic management of the FFG-7 Class to the Ship Acquisition Program Manager(SHAPM).

> Such dual responsibility was beneficial, in that it provided a continuity of effort in introducing the FFG-7 Class to the Fleet. After this initial phase, life cycle logistic management of the Class was transferred to the Gas Turbine Surface

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[9]U.S. Naval Sea Systems Command (PMS 399), Guided Missile Frigate Program Plan for Integrated Logistic Support of the FFG 7 Class, Washington, D. C.,2 October 1975.

> Combatant Ship Logistics Division (NAVSEA 914) on 1 June 1983....[10]

Under the Navy's standard Program Management organization, an ILS Manager was assigned to the Program Management Office (PMO). As depicted in Figure 3, FFG-7 Class ILS management is conducted within a very complex matrix organizational structure. The organizational structure is that typically found in DOD acquisition programs. An interesting point in this regard is the fact that the ILS effort was to be conducted within the constraints of the existing Navy organization and command structure.[11]

The hierarchical nature of the Navy's command and organizational structure brings an exceptional number of management layers into play when dealing with the myriad of elements associated with ILS. In essence, the elements of ILS are "farmed out" to the many different commands and participating activities which are tasked with the responsibility of carrying out particular ILS functions.

[10] U.S. Naval Sea Systems Command, History of the Oliver Hazard Perry Class (FFG-7) Shipbuilding Program 1974-1984, p. 2-1.

[11] Ibid., p. 5-52.

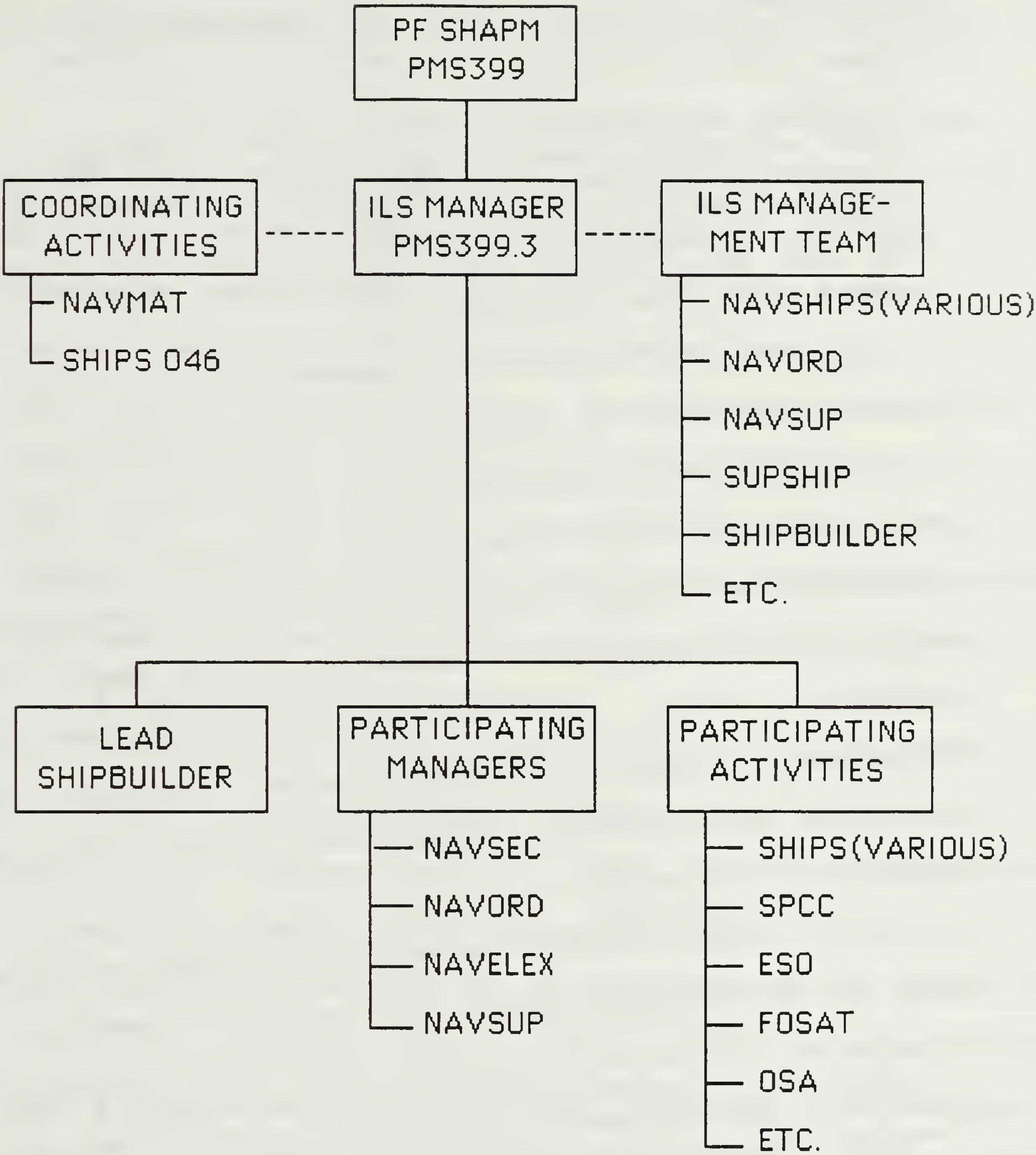

Figure 3. ILS ORGANIZATION FOR FFG-7 CLASS[12]

3. <u>"Fly-Before-Buy" Concept</u>

In an article published in the March 1978 U.S. Naval Institute Proceedings the FFG-7 Program

[12]Ibid., p. 5-53.

Manager(PM), Captain John D. Beecher, U.S. Navy, stated:

> Logistic support of the ship was a factor kept in mind at every phase of the design..... The use of "fly-before-buy" has permitted us to avoid the many growing pains normally associated with the lead ship of a class and provides a level of confidence in the capabilities and reliability of the follow ships now under contract.[13]

The "fly-before-buy" concept is not new to the Navy's acquisition process. Its use has been prevalent in the acquisition of DOD aircraft and its name refers to the practice of testing/"flying" and evaluating prototype aircraft in order to determine if design and performance characteristics meet those required before making large scale procurement decisions. Such a concept also reduces costs associated with design changes made during full scale production of systems.

The FFG-7 Class was to be the first major ship class to be procured under this concept. However:

> One doesn't "fly" a ship......the FFG-7 herself can almost be regarded as a prototype because of the two-year gap between her completion and that of the second ship in the class...... "Fly-before-buy" is a misnomer in more ways than the obvious. If you truly built a ship and tested her completely before you let a contract for the subsequent ships in the class, the gap would be so large that the technology would be behind you. The follow ships would be obsolete.... It takes four years for us

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[13]John D. Beecher, Capt, USN, "FFG-7: The Concept and Design," U.S. Naval Institute Proceedings, March 1978, pp. 148-150.

to build one of these ships from contract to delivery, and close to a year to fully test it.[14]

The FFG-7 Class Acquisition Program was a modification of the original Lead/Follow Ship concept. Under this modification, Land Based Test Sites and surrogate ships were used to test and evaluate the combat and engineering systems being installed in the lead ship. Lessons learned during the testing were incorporated into the design and production of the lead ship. In addition, the contracts for the first increment of follow ships was signed before the lead ship was launched (See years 1976 & 1977 in Appendix).

4. Design-to-Cost Concept

The FFG-7 Class Shipbuilding Program was the first major shipbuilding program to be undertaken under the "Design-to-Cost" (DTC) concept. The DTC concept is simply tailoring the design, development, and production process of a ship/system so that the ultimate cost is equal to the money available(financial ceiling) for building the required number of systems or units. In a broader context, DTC must also consider LCC; that is, it must include not only the costs to acquire a ship/system but also the costs incurred during the life of the ship/system.[15]

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[14]Ibid.

[15]S.E. Stephanou and Michael M. Obradovitch, Project Management, Systems Development and Productivity (Malibu, CA: Daniel Spencer, 1985) p. 234.

For the FFG-7 Class, the original DTC ceiling was set at $50 million per ship(FY73 dollars). After preliminary design work was complete, the DTC ceiling was set at $45.7(FY73 dollars) million per unit. However, as early as March 1978, the estimated cost of follow-on ships had risen to $68 million per ship.

On 18 October 1971, the Chief of Naval Operations established two other thresholds for the FFG-7 Class program in an attempt to decrease the LCC for the follow-on ships of the Class. First, a maximum of 185 accommodations were to be designed into the ship. This would limit the future LCC manpower costs associated with the deployment of the ship. However, the current Ship's Manning Document (SMD), dated 22 September 1983, provides a total manning for the ship's force of 202-209 personnel. Those numbers exclude personnel required to operate helicopters which would require an additional 20-29 acommodations depending on the helicopter type. Secondly, the maximum full-load displacement for the Class was not to exceed 3400 tons. This would limit the room for adding additional systems without removal of some other system, thereby limiting the total number of systems onboard and the associated life-cycle maintenance and support costs. This threshold has also been exceeded. The average full-load

displacement of the 1st and 2nd production flight ships is 3790 tons.

C. OTHER DESIGN PROBLEMS

Throughout the FFG-7's acquisition history, the PMO wrestled with numerous problems which appear to be ILS related.[16] More importantly, and contrary to the PM's statement, problems in the design occurred which should have been prevented by the proper application of the aforementioned ILS principles during the acquisition process. Some examples of design problems which were present in follow-on ships of the class are:

1. In spite of the Navy's extensive experience in designing and building salt water systems, the fire mains and the cooling water systems of the FFG-7 class ships have experienced significant problems. Ferrous materials and dissimilar metals were used in the fire main. Butterfly valves were used in the fire main and salt water cooling systems; gate valves should have been installed as a safety measure and to facilitate preventive maintenance. Heat exchangers in the auxiliary systems experienced rapid and destructive erosion from excessive

[16] A detailed listing of PMO concerns and problems is contained in "History of the Oliver Hazard Perry (FFG-7) Class, 1970-1984".

flow rates caused by the high pressure of the fire main supply.

2. Due to the use of bimetallic fittings on weather decks, topside corrosion created an unacceptable maintenance problem for the minimum manned crew. The fittings were selected as a maintenance free alternative to traditional fittings, but resulted in increased maintenance. This problem was so serious that it resulted in the promulgation of a FFG-7 Class Corrosion Control Manual in 1983. The Manual detailed a number of special coatings and fittings to be installed and refurbished at specified intervals throughout a ship's life-cycle.[17]

3. Even though the Navy has used diesel generators for years, the ship service diesel generators(SSDG's) selected for the FFG-7 class are a source of continuing problems and unreliable operation. This problem resulted in the formation of a Senior Navy Steering Board to review the problems associated with the FFG-7 Class SSDG's. As a result of the Board's

[17]While serving as the Engineer Officer, the author was unable to get the special coatings and fittings installed on the 25th ship of the class. The ship's Readiness Support Group(RSG) was not even aware of the Manual's existence and stated that no funding was programmed or available to carry out the requirements as set forth in the Manual.

review, consideration is being given to replacing the FFG-7 Class SSDG with a more reliable and proven system.

The above problems are only a sampling of the problems experienced and addressed by the PMO. The author experienced the above problems during his assignment to the twenty-fifth ship of the class (June 1982-July 1985). While the problems appear to be due to a lack of careful monitoring of engineering design, they should have been discovered, and therefore prevented, during the development of the ILSP which includes the Reliability and Maintainability (Interface) Plan.

Additionally, the PMO was not assigned responsibility as Life Cycle(Operational Phase) Manager until 1980, nine years after the start of the Conceptual/Design phase of the program. The author is unable to determine where this responsibility was assigned prior to 1980. It appears that the responsibility was fragmented among various NAVSEA elements. This absence of Program Mangagement attention to ILS considerations during the early design process might account for the problems (diesel generator selection, bimetallic corrosion, fire main, etc.) experienced as the class became operational. The Program Management Office should have been able to

detect those flaws during the initial design phase if its personnel had had responsibility for Life Cycle Management at that time.

D. OBSERVED OPERATIONAL PROBLEMS

1. Experience Base

The author's experience is limited to that of a commissioning engineer officer assigned to a OLIVER HAZARD PERRY (FFG-7) Class Guided Missile Frigate. The FFG-7 ILSP addressed the construction of forty-nine ships. The lead ship was delivered in 1977. The author was assigned to the twenty-fifth ship of the class in the second production block.[18] He reported to the building yard in Bath, Maine in 1982, five months prior to the ship's commissioning, and served as Engineer Officer for three years after commissioning. This span of time included the ship's CINCLANTFLT initial Light Off Examination in Bath, Maine, numerous inspections required for fleet certification, the ship's first major Sixth Fleet deployment, and finally, her first CINCLANTFLT Propulsion Examining Board(PEB) Operational Propulsion Plant Examination (OPPE). Previously, the author had been assigned to the Battle Group Staff which had

[18]Splitting the follow ships into blocks was intended to avoid the high cost-risks associated with multiyear contracts for all 49 ships, which would have stretched over long periods.

operational control of the lead ship during its first deployment in 1980 and which was also assigned as administrative commander for the follow-on ships homeported in Mayport, FL.

2. Operational Tasking

While assigned to the Battle Group Staff during the lead ship's maiden deployment, the author became aware of the first failure in the Navy's execution of ILS principles for the class. The FFG-7 class was originally designed to fulfill a mission of convoy escort. To fulfill that mission, it would operate in conjunction with high technology/expensive platforms to provide multi-threat protection to merchant or less capable service force shipping. During the lead ship's deployment, the author observed the ship's crew and officers struggle to make the ship perform in the very different role of serving in a Battle Group. A simple example was the ship's difficulty in maintaining a constant signal bridge watch within the Battle Group with only one rated signalman. The ILSP had provided manning for the low level of visual signaling required in convoy escort operations vice the much higher intensity required for Battle Group operations.

In the definitions above, an inherent responsibility exists for training the operational

commanders in the ILS process in order to provide them with a better understanding of the factors considered in designing a ship's manning plan. While the operational commander was fully aware of the FFG-7's purpose, he was not aware of the details associated with her minimum manning or the intricacies of her design considerations. As a minimum, one would think that NAVSEA would have given the operational commander definite guidance, in the form of operational scenarios, as to how the ship was to be utilized in order to evaluate and prove her ability to meet specific design characteristics. By no means is the author advocating limiting the operational commander's utilization of a fleet asset. However, the Program Management Office should have been actively involved with the operational commander in determining the operational tasking of the lead ship during her maiden deployment. This would have alleviated the forcing of the FFG-7 to perform as an element of the battle group when it was not designed for that purpose.

3. Technical Data

The second failure of ILS in the author's experience became evident as the ship attempted to establish a technical library. As the ship's delivery date approached, the ship was innundated with numerous technical manuals and drawings provided by the

contractor. An enormous amount of energy was expended by ship's company in attempting to track down technical manual shortages. The Ship's Drawing Index microfiche was delivered by the contractor with no index and the more than 20,000 microfiche cards in no particular order. Though the contract provided for the contractor to provide the material, it did not specify any condition. Additionally, many of the technical manuals received onboard were already outdated or in need of changes due to configuration changes in equipment. Liaison with the Supervisor of Shipbuilding and Repair proved fruitless in correcting these problems.

Keep in mind that the ship was minimum manned and that ship's company was involved in intensive training in actual ship operations during this pre-fleet certification period. Those cards and technical manuals contained technical information and diagrams of the ship's equipment and systems and were not readily available as a very valuable training tool during that period. And the manhours required for ship's force to sort and file 20,000 microfiche cards were not available. An additional result, as the ship became operational, was an increase in the time required to perform certain ship's force maintenance

actions due to the time required to locate specific technical data.

4. Repair Parts Support

Inadequacies in repair parts support also became apparent as the ship became a fully operational unit and progressed from funding out of new Ships Construction (SCN) to Type Commander operational funding. Parts for several critical systems were unavailable in the Navy Supply System and required direct liaison with manufacturers in order to maintain the ship in a fully operational status. While under warranty and in the SCN envelope, the ship experienced little or no problems with parts support. The building yard and Naval Sea Systems Command (NAVSEA) provided direct parts support outside of normal supply channels. However, once the ship was outside the SCN envelope, shipboard managers often had to deal directly with manufacturers to effect timely repairs to critical equipment.

A case in point concerned fuel filters for the General Electric LM2500 Gas Turbine Engine, the ship's main propulsion engines. The filters were listed as allowed onboard items in the ship's Consolidated Onboard Ship's Allowance List(COSAL), but were not in stock(NIS). The requirement for the filters arose out of the tasking of the ship to proceed underway for a

period of approximately 90 days of independent operations. Because no off-ship support would be available for that period, prudence dictated that spare filters should be onboard before sailing. After exhausting all efforts within the ship's chain of command, short of submitting a CASREPT(Casualty Report) saying that the ship's main engines were less than fully capable(which wasn't true), ship's force personnel procured the filters directly from the manufacturer at a tenth of the cost listed in the ship's supply manuals. Because the ship's main engines were in fact fully operational, a CASREPT would have been limited to a readiness rating which would not have allowed the assignment of a high priority to the requisition. If the crew had waited until the engines had actually been placed out of commission by a failed filter, the readiness rating on a CASREPT would have been such that the highest priority could have been assigned to the requisition and appropriate attention from higher authorities would have been brought to bear on the problem. Unfortunately, the ship's main engines would not have been operational while waiting for filters.

Numerous other parts were likewise not available in the supply system and, in some cases, were not even listed in the appropriate supply

manuals. Numerous ACR's (Allowance Change Requests) were submitted via the chain of the command. However, due to the time required for the processing of such paperwork through the various echelons of responsibility, submitting ACR's did little to solve the ship's immediate problem of being fully operation.

The author believes that the reason for such inadequacies is due, in part, to a serious lack of knowledge, on the part of operators, concerning the importance of the feedback systems associated with ILS. People in the fleet are primarily concerned with meeting day-to-day commitments. In meeting those operational commitments, operators often circumvent normal feedback systems for the sake of expediency. The process by which one gets a part to effect repairs to a system is not important. For an operator, repairing or maintaining his system in a timely manner is his foremost concern. As a result, many support requirements and conditions existing in the fleet are never reported via the feedback systems in place. The end result is that valuable information concerning the need for life-cycle support for the ship and its systems does not reach those individuals/activities responsible for providing that support. Thus, education of operators as to the importance of such feedback information is essential.

5. <u>Maintenance Planning</u>

The accomplishment of normal scheduled preventive maintenance provided further cause for dismay. The Class Maintenance Plan (CMP) relied heavily on Reliability Centered Maintenance (RCM). The ship was scheduled for an intermediate maintenance availability every six months in which preprogrammed maintenance or replacement of selected equipments was to be accomplished. These maintenance periods were conducted by the Ship's Intermediate Maintenance Activity(SIMA) in the ship's homeport, or by a Destroyer Tender when deployed. However, numerous maintenance actions were deferred due to non-availability of repair parts.

The lack of repair parts availability during these predetermined intervals increased the day-to-day maintenance workload on the minimum manned crew. Equipments scheduled for maintenance or replacement during Intermediate Maintenance Availabilities(IMAV's), but having such deferred due to non-availability of Ready For Issue spares, frequently required increased levels of maintenance by ship's force personnel in order to meet operational commitments. At the same time, some equipment initially required more maintenance than the Reliability, Maintainability, Availability, and

Supportability (RMA&S) data originally indicated.[19] This additional maintenance was not included in the development of the class manning plan and caused numerous difficulties in day-to-day shipboard operations due to the limited number of personnel available to accomplish such tasks. Finally, maintenance activity personnel lacked the required training and equipment to accomplish many of the preprogrammed maintenance actions.

A combination of the non-availability of Ready For Issue spares and the non-availability of other repair parts to perform preprogrammed maintenance meant that the Class Maintenance Plan and the minimum manning concept, the two principal ILS objectives of the ILSP presented on page 23, could not be achieved.

6. In Summary

While ILS is indeed a logical and systematic approach to ship acquisition, the Navy's execution of its principles for the FFG-7 Class fell short of achieving its objectives. With the myriad of activities and organizations contributing to the overall execution of ILS, it is hard to pinpoint the reason for such deficiencies in logistic support after more than 25 ships had been commissioned. However,

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[19] Design reliabilities are not easily attainable. There is a 50% chance of worse performance, i.e., lower reliability.

the author believes that the deficiencies stem from 1) a lack of effective communication between shipboard managers/operators and those individuals/activities responsible for ship design and providing direct logistic support and 2) an absence of accountability among those individuals/activities for carrying out specific actions required to support fleet units.

IV. WHERE SHOULD WE GO FROM HERE?

A. SUMMARY

Integrated Logistics Support(ILS) is a disciplined, unified, and iterative approach to the management and technical activities necessary to: (a) integrate support considerations into system and equipment design; (b) develop support requirements that are related consistently to readiness objectives, to design, and to each other; (c) acquire the required support; and (d) provide the required support during the operational phase at minimum cost. The U. S. Navy became serious about ILS due to shrinking defense budgets and the potential cost savings afforded by its application to the system acquisition process. DOD guidance requires that ILS be considered throughout the acquisition process in order to assure cost consciousness and effective life-cycle support for fleet systems. It pulls together concept, design, test and evaluation, production, and operations into the continuous development of systems to be used by today's Navy.

The FFG-7 Class Shipbuilding Program provided the arena for the Navy's first application of ILS principles to the acquisition of a major class of ships. The FFG-7 Class program also provided for the Navy's first application of the "fly-before-buy" and

"design-to-cost" concepts to a major shipbuilding effort. The purpose of implementing the three concepts was to minimize the LCC associated with acquiring, maintaining, and supporting the ship class.

Experience and research point to several problems in the FFG-7 Class Shipbuilding Program which raise questions regarding the effectiveness of the Navy's application of ILS principles to that ship class. Those problems in the areas of design, evaluation, production, and operations could have been effectively dealt with within the framework of a properly executed ILSP.

B. CONCLUSIONS

1. FFG-7 Class Acquisition Program

The FFG-7 Class Shipbuilding Program is the Navy's first major shipbuilding program in which ILS was attempted. While the ILS effort was directed by a myriad of DOD, SECNAV, and OPNAV instructions, its execution has left much to be desired. However, there are lessons to be learned from the procurement of the FFG-7 Class ship. These ships were to be small inexpensive surface combatants capable of providing open ocean escort support for amphibious, logistical, and merchant convoys in a low threat environment. Instead, the Navy has procured a class of not so inexpensive and highly capable ships. Examples of

increased capabilities include the addition of the 2 helicopter hangars, the missile launcher, the towed array system, and the fin stabilizers.

Unfortunately, the ILS process for the Class proceeded under the original cost and design constraints. The FFG-7 Class ILSP should be updated to reflect the logistics support required for the ship class as it is being utilized in the fleet today. Life-cycle logistics support requirements for high tempo/high threat battle group operations are quite different from the requirements for low tempo/low threat convoy escort operations.

The FFG-7 PMO should review the life-cycle Required Operational Capabilities(ROC) for the ship class, develop a plan for life-cycle Pre-Programmed Product Improvement(P^3I), and continually monitor and update both the ROC and the P^3I plan. This would require planning in excess of the current Five Year Defense Plan (FYDP).

The design-to-cost concept appears to also have fallen short of its objectives. The follow ships unit cost goal was exceeded by more than 36%($18.3M over the $49.7M goal). And ironically, the effect of the accommodations and displacement constraints imposed by the CNO was the opposite of that intended. While the constraints were an effort to limit costs,

the emphasis on Design-to-Cost lead to artificial design constraints which were not workable and which now require costly fixes later in the FFG-7 Class life-cycle.

Additionally, if the Navy had built a prototype ship and tested her completely before letting contracts for subsequent ships in the class, other design problems could have been solved. For example, the costly reliability problems associated with the FFG-7 Class ship's service generators would have been discovered during prototype testing. Thorough testing and evaluation of the generators would have eliminated nine years of excessive and costly maintenance as well as consideration of a plan to replace the 216 generators on the 54 ships already in service.

2. General Conclusions

The acquisition of a large class of ships is a complex and costly undertaking. To bring the myriad of elements which comprise the ILS effort to bear on the process of acquiring ships/systems in the most efficient manner possible, requires an acquisition environment which supports the intensive effort required to achieve ILS objectives. As the U.S. Navy attempts to meet mission requirements within the financial constraints imposed by changing

Administrations and Congress, it must acquire its systems in the most efficient manner possible. Inclusion of Integrated Logistics Support is the process which makes such efficiency possible. When the principles of ILS are properly applied, the magnitude of the LCC savings achieved will become obvious, even if not entirely measureable.

The Navy's ability to accurately predict long range LCC appears to be in its infancy. In support of design-to-cost objectives, the Navy must develop the quantitative techniques necessary to reduce the magnitude of the uncertainty associated with LCC estimates. Without improvement in this area, it will be very difficult to convince Congress to pass legislation allowing DOD to procure ships on a multi-year, life-cycle support basis. In any case, the commitment of financial resources for the life of a ship/system is essential to the achievement of ILS objectives.

Operational and administrative commanders must understand that the operational employment of ships is a major consideration in the design and execution of ILS principles and should maintain active and effective communication with the Program Management Office throughout a ship's life-cycle. Officers at every level of the chain of command should be educated

in ILS principles and the importance of those principles in meeting readiness and logistics support objectives. The Navy should also implement communications channels which promote the timely, free, and effective exchange of valuable logistics support information both up and down the chain of command.

C. RECOMMENDATIONS

The author recommends the following actions with regard to the execution of ILS principles in future Navy shipbuilding programs. The recommendations are also applicable to the FFG-7 Class Shipbuilding Program.

1. It is recommended that DOD move toward a strategic planning process which coincides with the life-cycles of the ships/systems it procures. The current Five Year Defense Plan (FYDP) appears inadequate. For the FFG-7 Class, that would mean developing a plan spanning 20-25 years. Pre-Programmed Product Improvement(P^3I) covering this period could alleviate fluctuation in program objectives and give the Program Management Office time to fully test a ship system in its operational environment before committing enormous financial resources to its full procurement.

2. While ILS Managers are currently assigned the responsibility for the life-cycle support of acquired systems, it is recommended that they also be given the authority to implement that support. Such direct control should include the responsibility and authority to obligate the budget, to procure and distribute repair parts unique to the particular ship/system, and to provide configuration management of the ship class. Such authority should also include direct control over all the people/activities performing such tasks.
3. The Program Management Office must continually review design changes and the operational employment of procured units and ensure that the ILSP is updated to reflect support requirements for particular design and employment scenarios. The FFG-7 Class requires immediate attention in this area.
4. It is recommended that the Navy establish a program to train operators/managers in the principles of ILS and their impact on the achievement of ILS objectives. Such training must extol the virtues of life-cycle support and teach shipboard managers (1)how ILS impacts on their ability to use the

ship/system in accomplishing its mission and (2)what they can do to improve the life cycle support for their systems. If the Navy intends to reap the benefits of effective ILS efforts, it must bring the people who manage its ships/systems during the operational life-cycle into the overall process. Every manager/leader who exercises any administrative or operational control over a ship/system should be aware of the decisions which guided its development and ILS strategy. Additionally, these same operators must have a direct, open, and responsive line of communication to and from the ILS management team throughout the life of the ship/system.

APPENDIX

FFG-7 CLASS ACQUISITION CHRONOLOGY

1970

09 September	OPNAV initiated feasibility study.
31 December	Program Budget Decision(PBD) 507 was released, indicating "Navy should expedite action on the new design escort ship...to be built in quantity for a unit cost of about $50 million..." NAVSHIPS released report on the status of the PF feasibility studies confirming "the general feasibility of an ASW Patrol Escort in the $40-$50 million range for follow ships." Conclusions regarding probable costs for the more costly AAW configuration were not provided.

1971

12 January	The CNO approved proceeding into PF Con-ceptual Phase.
13 March	SHAPM presented interim report to the CNO indication feasibility of FY73 award for lead ship.
06 May	The CNO selected PF payload characteristics and generally approved PF lead ship-follow ship procurement concept in lieu of a more time-consuming and costly PF prototype. A limiting full-load displacement of 3000 tons was provisionally imposed.
14 May	COMNAVSHIPS advised OPNAV by memo that the 3000 ton limit was unrealistic, suggesting 3500 tons as a practical limit. Further, he suggested limiting cost rather than displacement as a more appropriate control.
20 May	The CNO selected single shaft propulsion alternative and established $45 million as upper limit of follow

ship cost in FY73 dollars and an upper limit of full-load displacement of 3400 tons. Predicted full load displacement at that time was 3765 tons, with the following characteristics in comparison with today's characteristics:

1 helo vice 2 helos
Cruise engine vice no cruise engine
SQQ-23 (pair) sonar vice SQS-56
35mm vice 76mm OTO MELARA gun
TACTAS space and weight

01 June	NAVSEC commenced preliminary design.
12 July	PF Advance Procurement Plan (APP) was submitted to NAVMAT, based on assumed receipt of $51.6 million FY72 funds.
30 July	President Nixon submitted to Congress amendments to the request for DOD appropriations, including PF request for $51.6M.
01 August	PMS399 was asigned ship acquisition responsibility for PFs.
August	Senate Armed Services Committee rejected request to amend the budget to provide $51.6M for PF.
15 September	The CNO approved 2-block approach and associated late ship deliveries resulting from cutback of FY72 funds.
08 October	APP was re-submitted to NAVMAT to reflect changes due to FY72 cutbacks.
18 October	CNO established thresholds for accommodations (185; a reduction of 30 through reduced maintenance work load), full load displacement (3400 tons), and redefined the $45M cost ceiling for follow ships to exclude shipbuilder escalation.
05 November	Original APP was approved.
08 November	Industry Briefing was held for potential PF shipbuilders.

15 December	Request for proposals for Ship System Design Support (SSDS) was released.
21 December	COMNAVORD and COMNAVSHIPS, in a joint letter, advised CNO of necessity for second UYK 7 computer.

1972

18 February	SSDS proposals were received.
25 February	CHNAVMAT was briefed by SHAPM on computer problem noted above due to inaction on part of CNO. CHNAVMAT sent memo to CNO personally reaffirming need for second computer.
12 April	SSDS contracts were awarded.
26 April	CNO Executive Board (CEB) was briefed on computers by OP-03D and SHAPM.
01 May	CNO memo for the record approved second UYK 7 computer with 16,000 word memory limitation. CNO also directed feasibility study be made ASAP for dual helo hangars in PF. Weight and space for Close-in-weapons-system were also added as characteristic requirement.
20 May	The CNO modified PF characteristics: 2 vice 1 helo, 76mm vice 35mm gun, SQS-505 type vice SQQ-23 sonar, and imposed a $300K limit on the Electronic Warfare(EW) suite. Weight and space for helo hauldown system added.
05 June	NAVSHIPS documented revised average cost estimate of follow ships to $45.7M. NAVSHIPS also recommended that Future Characteristics Change(FCC) reserves be established and that mechanical stabilizer be incorporated in the design.
27 June	OPNAV directed weight and space reservation for an unspecified electronic device with antenna to be located above pilothouse. Attempts to obtain engineering details from OPNAV were fruitless.

09 August	Revised APP was approved.
17 August	OP-03D approved dual helo hangar arrangement.
24 August	OPNAV concurred in the revised cost of $45.7M. FCC reserves were disapproved. Space only for stabilizers was authorized.
27 September	SECDEF authorization was granted to proceed with development and construction of the lead ship, land-based test sites, and advance procurement funding.
24 October	CNO issued approved characteristics for PF. ("Plan for Use" and other Top Level Requirement (TLR) items were not included.)
11 December	Preliminary Allocated Baseline (PABL) was completed and circulated within the Navy and to the SSDS Contractors for review and comment.

1973

05 February	Fleet input to CIC design requested addition of an Operational Summary Console.
20 February	OPNAV requested redesign of the ship control console so as to provide the capability for either the helmsman or the OOD to man ship controls on a share basis. This required major redesign of console due to change in concept and dual control requirement.
26 February	PABL Review was completed.
13 April	PABL comments were adjudicated.
19 April	Lead Ship Allocated Baseline (LSABL) was completed.
01 May	Bath Iron Works (BIW) SSDS contract was modified to include startup of Detail Design, with exception of bridge.

17 May	RFP for the Detail Design and Construction of the PF lead ship was released to BIW.
05 June	Patrol Frigate (PF) Ship Acquisition Plan was issued.
11 June	Due to a lack of OPNAV action on TLR submitted 24 Oct 72, SHAPM extracted the "Plan For Use" section and submitted it to OPNAV for approval in view of implications for the Navy's maintenance planning for PF's. OP-097 then requested the TLR be revised to in accordance with latest CNO-CHNAVMAT agreements on format and the "Plan for Use" be incorporated therein rather than issued as separate document. Although repeated attempts had been made with OP-097 staff to expedite the TLR, it had never been issued. Hence, the "Plan for Use" as submitted was used by NAVMAT in maintenance planning.
15 June	BIW proposal for Detail Design and Construction was received.
July	Test and Evaluation (T&E) coordinated meetings commenced among OP-097, OP-98, COMOPTEVFOR, SYSCOMS and SHAPM.
21 September	NAVSHIPS documented revised average cost estimate of follow ships to $47.7M, reflecting lead ship negotiations.
29 October	SECNAV approved award of the Lead Ship Contract to BIW.
30 October	Lead Ship Contract for Detail Design and Construction was awarded to BIW.
31 October	BIW SSDS contract work was completed.
18 December	Final draft of TEMP (Test & Evaluation Master Plan) was forwarded to OPNAV for approval.

1974

02 January	The FY74 Defense Appropriations Act excluded advance procurement funding of guided missile launcher components requested in FY74 in support of the FY75 program year, resulting in a predicted four month delay in follow ship deliveries.
January	It was determined that the FFG-7 would require an additional ship's service diesel generator (SSDG) set because of increasing electrical load.
25 March	TEMP approval was received.
March	Fourth SSDG was added to FFG-7 contract baseline and delivery date was extended to June 1977.
17 December	Fabrication of FFG-7 (the lead ship) was started.

1975

03 February	Initial "Top Level Requirements" were issued.
April	Testing of FFG-7 propulsion plant at Propulsion System LBTS was started.
12 June	Keel of FFG-7 was laid.
September	Design and integration of Combat System was accepted by Navy after successful development and operational testing at the Combat System Test Center.

1976

02 January	Loading of main machinery of FFG-7 was started.
February	Contracts for first increment of follow ships were signed with BIW; Todd, Los Angeles; and Todd, Seattle.
25 September	FFG-7 was launched.

September	Contract delivery date for FFG-7 was extended from June 1977 to 31 December 1977 to accommodate a rearrangement of the Combat Information Center.
12 December	Fabrication of FFG-8 was started.

<u>1977</u>

February	Contracts were awarded for FY77 ships.
20 April	Testing of the Combat System computer program was started.
29 April	Keel of FFG-10 was laid at Todd, Seattle.
13 July	Keel of FFG-9 was laid at Todd, Los Angeles.
18 October	FFG-7 builder's trials were started.
16 November	FFG-7 Acceptance Trials were completed.
30 November	FFG-7 was delivered to Navy one month ahead of contract delivery date.

<u>1978</u>

January	Contracts for FY78 ships were awarded.
10 August	"Plan for Use," OPNAVINST C9000.4, was issued.
26 October	Post-Shakedown Availability for FFG-7 was started at BIW.

<u>1979</u>

April	FY79 ship construction contracts were awarded.
19 November	PMS399 promulgated the "Class Maintenance Plan."

<u>1980</u>

March	Completed ship design for FY79 ships.

01 October	Responsibility as Life Cycle (Operational Phase) Manager for FFG-7 Class was assigned to PMS399.
November	FY79 Combat System integration design specifications were completed.
December	PMS399 conducted first FFG-7 Class Program Review for OP-03.
December	PMS399 conducted first Deficiency Corrective Action Program (DCAP) Review for CHNAVMAT.

<u>1981</u>

February	FY79 Combat System performance specifications were completed.
March	Started FY79 Combat System integration testing at Combat System Testing Center.
April	FY79 working drawings were validated.
15-16 October	FFG-7 Ship Class Program Review was conducted by DCNO (Surface Warfare) in Washington, DC.

<u>1982</u>

January	PMS399 conducted Acquisition Appraisal for Assistant SECNAV.
05 February	Technical/Operational Evaluation of LAMPS III weapon system in the USS McInerney(FFG-8) was successfully completed.
April	OPNAV approved a Revised TLR for the FY79 Baseline.
04 June	A firm, fixed-price, letter contract for full production of fin stabilizer systems was awarded to Brown Brothers and Company, Ltd.
25 June	Eleven weeks of operational test and evaluation of the FY79 Combat System were successfully completed at the

	Combat System Land Based Test Center. No major design problems appeared.
October	A prototype fin stabilizer system was installed in the USS Gallery (FFG-26) during its Post-Shakedown Availability. Initial at-sea tests were satisfactory.

1983

14 January	FFG-36, the first FY79 Baseline ship, was delivered to Navy.
01 June	"FFG-7 Class Life-Cycle Configuration Management Plan" was issued. SEA 914 was assigned responsibility as Life-Cycle (Operational Phase) Manager of the FFG-7 Class ships.
28 November	First class of Gas Turbine Technician students began FFG-7 Class propulsion system operating training on the "Hot Plant" at the Great Lakes Naval Training Center.

1984

28 February	The USS Underwood (FFG-36) completed her Post Shakedown Availability at BIW, during which she became the first U.S. Navy ship to be equipped with the production version of the LAMPS MK III and the Fin Stabilizer System.
17 May	The Navy Tactical Interoperability Support Activity granted U.S. Navy Interoperability Certification to the FF-7 Class FY79 Combat System Baseline LINK 11 Program.
28 November	The contract for construction of the single FY84 FFG-61 was awarded to Todd, Los Angeles. However, performance of the contract was constrained by a shortage of funds. Congress originally directed that this ship include an upgraded MK 92 Fire Control System and an X-band phased array radar. Subsequently, at the request of the Navy, Congress approved construction of

the ship with an upgraded MK 92 and a coherent receiver transmitter.

29 November	The follow-on contract for Fin Stabilizer Systems was awarded. This contract included the procurement of these systems for retrofit on all FY78 and earlier ships.

ABBREVIATIONS AND ACRONYMS

ACR	Allowance Change Request
CASREPT	Casualty Report
CBR	Chemical, Biological, & Radiological
CINCLANTFLT	Commander-in-Chief, Alantic Fleet
CMP	Class Maintenance Plan
DOD	Department of Defense
DODD	Department of Defense Directive
DTC	Design To Cost
ESO	Electronics Support Office
FOSAT	Fitting-Out Support Activity
FSD	Full Scale Development
FYDP	Five Year Defense Plan
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IMAV	Intermediate Maintenance Availability
LBTS	Land Based Test Site
LCC	Life Cycle Costs
LSA	Logistics Support Analysis
LSAP	Logistics Support Analysis Plan
NAVELEX	Naval Electronics Systems Command
NAVORD	Naval Ordnance Command
NAVSEA	Naval Sea Systems Command
NAVSEC	Naval Security Command
NAVSHIPINST	Naval Ships Systems Command Instruction
NAVSUP	Naval Supply Command

OPNAV	Operations, Navy
OPPE	Operational Propulsion Plant Examination
PEB	Propulsion Examining Board
PM	Program Manager
PMO	Program Management Office
RCM	Reliability Centered Maintenance
ROC	Required Operational Capabilities
RMA&S	Reliability, Maintainability, Availability, & Supportability
SCN	Ships Construction, Navy
SECNAVINST	Secretary of the Navy Instruction
SHAPM	Ships Acquisition Program Manager
SMD	Ship's Manning Document
SPCC	Ships Parts Control Center
SUPSHIP	Supervisor of Shipbuilding & Repair Command

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